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BUREAU OF MINES
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INFORMATION CIRCULAR

WHAT IS THE RESPONSIBILITY OF THE COAL-MINE OFFICIAL IN THE PRESENT CHANGE TO AND FUTURE OF MECHANIZED MINING?

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BY

D. HARRINGTON

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UNITED STATES DEPARTMENT OF THE INTERIOR - BUREAU OF MINES

WHAT IS THE RESPONSIBILITY OF THE COAL MINE OFFICIAL IN THE PRESENT CHANGE TO AND FUTURE OF MECHANIZED MINING?[1]

By D. Harrington[2]

INTRODUCTION

The placing of much, sometimes practically all, of the burden of the expense of mine accidents on the shoulders of the mine operator by compensation laws, and the fact that the problem of protecting the life and limb of workers is now by public opinion largely if not wholly passed to each industry to solve (and present-day thought strongly supports the justice of both of these propositions), are forcing industrial organizations into accident-prevention work. This policy is being adopted not alone to protect the companies; in addition, executives alert to their opportunities and obligations are taking part in this work personally to protect themselves. The functions of industrial executives in accident-prevention work are becoming numerous and complex. Executives who are logical in their reasoning, quickly see that before a company can consistently ask or expect the workers to heed safety suggestions, the company and its officials must "put their house in order" by laying down a concrete, definite safety program. For mines this includes primarily adoption of a logical mining method, the installation of safe mining equipment and practices, the setting forth in definite form (preferably in a printed pamphlet) of the company's minimum safety requirements, and the organization of its operating officials into an accident-prevention body. After the company has its own affairs so arranged that it can go to its workers with "clean hands" in promoting a safety program, the real work begins; and this is especially applicable in mining.

HAZARDS OF MECHANICAL EQUIPMENT

Little as mining men may desire to acknowledge it, there is no doubt that nearly every piece of mechanical equipment introduced into our mines adds new hazards in operation, and this is the more likely to be true when the equipment is operated by electricity. It is due largely to this fact that the accident rate in both coal and metal mining in the United States has for years doubled, tripled, or quadrupled that of European mines. It is also due largely to increasing utilization of mechanical equipment, especially

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Revision of an address presented before the Pittsburgh Coal Mining Institute, Pittsburgh, Pa., February 24, 1939.

2/ Chief, Health and Safety Branch, Bureau of Mines, Washington, D. C.

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electrically operated equipment, in coal mines that it has been so difficult to make any appreciable reduction in our frequency or severity accident rate until the past few years. In particular, explosion and fire hazards in coal mines have been greatly augmented by the increased use of electricity, and the relative immunity from explosion and fire disasters in coal mines during the past 5 or 6 years is due partly to "luck" but in many instances to the adoption of more effective safety methods not only in mechanized but in essentially nonmechanized mining plants. In other words, our coal-mining people are now far more safety conscious than has been true in the not far distant past.

The effect on accident occurrence of the substitution of machinery for man power in loading coal at the face is now much debated. The main safety arguments advanced by proponents of mechanization are that the machines greatly reduce the number of men needed for underground operations, hence there is automatically a decrease in the accident hazard; moreover, that the machines concentrate the work and allow intensive supervision, now conceded to be one of the most effective methods of bringing about safety. Opposed to this reasoning is the fact that the introduction of mechanized contrivances into the confined spaces usually available at coal-mine faces introduces definite hazards from contact with moving parts or with electricity; moreover, where workers are massed around machines there is the danger of multiple accidents should there be falls of roof, small gas or dust ignitions, runaway cars, premature explosions in blasting, etc., and multiple accidents from all of those causes (as well as others) actually have occurred.

The process of substituting machinery for men in loading at the face has not become widespread enough or in effect long enough to afford adequate data on which to base definite conclusions regarding the relative safety of the old hand-loading compared to the newer mechanized-loading methods. The fragmentary data at hand, however, tend to indicate that when installed and operated with reasonable safeguarding of the mine and its workers, the newer methods can be made to give good results in safety. On the other hand, there is a decided tendency to take it for granted that mechanized loading is automatically safe. For this reason safety usually is given little or no consideration in the installation or operation of these newer methods, and there is much reason to believe that, during the first few years of their use at least, safety is likely to be lessened rather than enhanced by them.

NEED FOR TRAINING EMPLOYEES TO HANDLE MECHANIZED EQUIPMENT

One of the worst features of the substitution of the newer mechanized for the older and more primitive "hand" methods is the fact that the mine workers, including the bosses, are confronted with different conditions of work from those that had previously been in effect not only during their working lives but also those of their fathers. This greatly enhances the hazards introduced with mechanized methods and makes it almost obligatory that workers and bosses alike be carefully and thoroughly instructed in the methods of installation and use of the newer types of procedure as well as in the new hazards introduced and the ways of avoiding or even causing them. Unquestionably this educational training should be given to the bosses first

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if it is feasible to do so; then they will have most of the "job" of putting over to the workers the essential information already acquired.

ORGANIZING SUPERVISORY FORCE

Here are some suggestions for organizing the supervisory force so as to try to obtain the cooperation of all workers in promoting mine safety in connection with mechanized mining of coal:

(1) Every mine, large or small, should have a definite, active, and constantly functioning safety organization, preferably with the operating head of the company or the mine taking personal lead at the meetings, active participation of all bosses, and, if possible, participation of all surface and underground workers or committees representing them. There should be periodical (possibly monthly) safety meetings at which accidents are discussed, safety talks made, and bonuses or other awards should be distributed; these meetings should be devoted exclusively to safety discussions and certainly should not be spoiled by introducing such potential causes of friction as controversies on cleaning coal, wages, or hours.

(2) Every mining company, large or small, should educate its workers, including the bosses, in safe and efficient mining practices and methods not only as to mechanized mining but also as to the older types of mining. One fallacy that has contributed probably more than any other to the present hazards of mining is the almost universally prevalent idea of mining men that miners of long experience know how to protect themselves. The cold facts are that the usual old-time miner reads practically nothing on safety or efficiency in mining, and hence knows little or nothing but what he himself has seen or what he has learned from some equally poorly informed miner or boss who has just emerged from the ranks of the miners. The Safety Division of the Federal Bureau of Mines has established a list of mining people to whom mimeographed safety literature is forwarded as issued; those who wish to receive this safety literature can do so by applying to the Safety Division, Federal Bureau of Mines, Washington, D. C.

(3) There should be a supervisory official or boss for about every 25 men, always on the job during the shift to oversee the work and to protect the interests of the company as well as the safety of the employees. This is not an additional cost to the company, as definite experience in many parts of the country in nearly all kinds of mines shows that if the supervisory official or boss is properly trained in his work, both as to safety and efficiency, he can much more than save the amount of his wages.

Since there are at least 25 and in some instances 100 or more mine workers for every supervisory official, it is manifestly much easier to give safety education to the officials and have them

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transmit the information to the other workers than to try to reach the entire working force directly. Here is where intensive supervision and discipline come in - and by discipline is meant not utilization of "hard-boiled" methods of handling men but rather establishment of common-sense, up-to-date regulations, seeing that they are transmitted to the men, and finally insisting that these regulations be obeyed and without reservation or delay. The Federal Bureau of Mines has a worthwhile accident prevention course for officials of coal mines, and wideawake, safety-conscious coal-mining companies should take advantage of it for the benefit of the supervisory force in its efforts to "put over" the safety idea.

(4) Every mine should have in printed form, and preferably in a small pamphlet which may be kept in the pocket, its minimum safety (and possibly efficiency) requirements, with provision for alterations, additions, etc., to the data in the pamphlet from time to time. These rules or regulations should be specific and should conform to the State law but should go far beyond the requirements of the State law, as no State has mine safety laws or regulations which are anything like up-to-date or adequate enough. Moreover, every employee should be required to keep thoroughly familiar with these rules; in fact, many progressive companies cause employees to be examined from time to time on safety rules and regulations. Every employee (including bosses as well as other workers) is most certainly entitled to have definite information on at least the minimum safety requirements of the company; and the best-known method of conveying this information and of keeping a continuing, permanent record thereof is by means of printed (pamphlet) rules or regulations.

(5) An excellent method employed by some mining companies to keep employees informed about safety and other requirements or developments or pertinent information is to address to every employee from time to time mimeographed or multigraphed letters signed by the president or general manager or other high official. In some instances these letters are sent to the home of the worker, in others they are delivered to him at his working place; this is far more effective than the posting of typewritten letters. Some large companies do good safety work by having a printed or mimeographed monthly publication; and unquestionably the use of moving pictures (especially the talking picture) is one of the most effective methods of conveying safety ideas to the workers. The Bureau of Mines has some coal-mine safety motion pictures that are available to the industry upon request.

(6) The operating organization should obtain the cooperation of the field force of State or county inspectors of mines to be available for the forwarding of an intensive and continuing safety campaign in mines, but as a prerequisite the mining people should use their best efforts and influence in trying to see that these officials are authorized to attend safety meetings both within and

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outside of the State, such as those of the National Safety Council. In addition, they should be supplied with membership in the National Safety Council or other similar organizations to have up-to-date data on safety in mining available.

(7) One of the cheapest, easiest, and at the same time most effective methods of bringing safety-mindedness to the mining personnel, officials as well as miners, is training in first aid to the injured of the entire personnel. This training work does not reach anything like its full effectiveness unless every person above and below ground at a specified mine takes it. In the past, or up to about 1926, first-aid training was given to but relatively few persons at any one mining plant, and this system was fully as ineffective as if only 5 or 10 persons out of every 100 in underground mining were to know how to protect themselves from falling rock or from dangers from falling roof, haulage equipment, explosives, and other causes or influences. With the entire personnel kept trained in first aid, the training becomes valuable in preventing accidents in addition to helping to minimize their ill effects if they should occur. Here again the Bureau of Mines has available to the industry facilities for the giving of courses in first aid.

(8) To stimulate safety in mining, safety contests between mines or departments of mines are used to advantage. Giving wage, salary, or some other type of bonus to workers for safety results or to bosses whose personnel achieves or excels predetermined safety accomplishments is productive of much good; in fact, a well-thought-out bonus system is one of the most effective methods yet devised to "put over" safety to the workers and bosses. Some companies give recognition (financial or otherwise) to individual workers in mines or sections of mines or to mining personnel who work stated periods, such as 3 months, 6 months, a year, or longer, without lost-time accidents; some companies give a copper button for 3 months work without a lost-time accident, a silver button for 6 months, and a gold button for a year without a lost-time accident. Numerous other rewards of the nature of a bonus are used and some that are not successful in one mine or plant are eminently successful elsewhere. Giving some sort of reward for safety performances is very much worth while, and it is very desirable that this be extended to the individual workers as well as to the mine officials, particularly where penalties for infraction of safety rules are in force.

(9) Every mining company, large or small, owes it to itself, its employees, and in a large measure the public to see that all prospective employees are given a rigid physical examination before being employed, as well as at intervals of not to exceed a year during employment. Although mining can be made relatively safe, it is futile to deny that it is a strenuous occupation; and persons with defective hearing, eyesight, respiration, and heart should not be so employed, for they are a menace to themselves as

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well as to their co-workers. It is far more unjust to employ a physically defective person and probably cause him to acquire additional and more serious physical deficiencies or possibly to die in a mine or cause his coworkers to be killed or injured, than it would be to refuse him employment upon learning of the defect or even to relieve him of employment if he becomes physically defective to such an extent that he endangers himself or others. Undoubtedly, if more care were taken in hiring mine employees (bosses as well as the other workers) and in their instruction upon employment and afterward, safety and efficiency in mining would be materially increased.

(10) Many mining companies are now making remarkable progress in accident prevention through use of protective clothing, such as hard hats, various kinds of hard-toed shoes and other foot and leg protection, goggles, safety belts, etc. In many instances it has been difficult to obtain the cooperation of the workers, but usually this reluctance can be overcome if the mine officials will pave the way by themselves using the recommended materials consistently; where at all feasible the protective clothing should be furnished at cost or possibly given outright as a type of safety bonus. In some cases it has been found necessary to require the use of the protective clothing, but where good judgment is used, compulsion should not be necessary, except possibly for a few persons.

(11) Coal mines have been fortunate in recent years in having avoided many fire and explosion disasters. The word "fortunate" is used advisedly, because the avoidance has been due more to good luck than to any considerable amount of effort on the part of many of the mining companies, largely because coal-mining people in general are far too generally of the opinion that while the "other fellow's" mine may be subject to fires or explosions their mines are essentially immune. As a matter of fact, there is probably not a single coal mine in the United States that does not have very definite fire hazards, and very few if any are free of the danger of explosions. There is almost universally in coal mines the extremely dangerous combination of combustible material and flame; and a very little burning coal or timber or burning explosive can readily produce enough poisonous or asphyxiating gases to kill hundreds of persons. Every coal-mine operator and employee should recognize the hazard of fire or explosion, and every mine should have a fire-prevention and fire-fighting plan and a well-thought-out procedure for preventing explosions and handling them adequately if they should occur.

(12) The ever-increasing use of electricity in mining introduces many new and serious hazards, such as the initiation of fires and explosions and accidents from contact of persons with charged electrical installations of various kinds. Utmost care should be taken in the purchasing, installation, use, and maintenance of all electrical equipment or devices in or around mines. At least

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as frequently as once each month a competent electrician should make a rigid inspection and a written report of the condition of all electrical wiring, machinery, etc., in or around every mine; and prompt action should be taken to follow his suggestions in keeping such installations in safe condition at all times.

(13) Explosives accidents continue to occur too frequently in some coal mines; there should be the greatest care in the choice of explosives used and in the storage, transportation, charging, and firing of explosives, and only explosives and explosives appurtenances of the safest types should be used. In general, electrical blasting is much safer than blasting by fuse, but electrical blasting is by no means "foolproof". If at all feasible, blasting should be done only at the end of the shift, or possibly by shot firers after the general shift has left the mine.

(14) Consistence on the part of the mining companies demands that before asking or requiring the employees to alter the old for the newer and safer practices, they should first "put their house in order." This means that in addition to suggestions previously made mines should be well-ventilated, and all nonanthracite mines should be kept well rock-dusted; that well-constructed cages or man cars be supplied to transport the men into or out of the mine; that all mines have more than one travelable exit; that all exits have well-placed and well-constructed fire doors for use in case of necessity; that all cages have practical and workable doors which are closed at all times when men are aboard; that all of the openings to shafts, winzes, raises, or steep inclines have adequate doors or other device to prevent falling of men or material into them; that ladderways in shafts, raises, or winzes over 70° pitch have platforms at intervals at least every 30 feet and that such ladders and ladderways be kept clean and in good repair; that all machinery be kept adequately guarded; and that timber supply be ample, of correct size, length, etc., and placed reasonably close to the point of use. In fact, if the worker's full cooperation in safety effort is to be obtained and maintained, the employer should by all means do his utmost to provide the worker with a safe place in which to do his work.

There is now no question but that mines can be operated essentially as safely as most of the other lines of industrial endeavor, and there is good reason to believe that safe operation is also economical and efficient operation. However, to bring about this safety will require the expenditure of much personal thought, time, and effort, not only by those who actually go into the mines to do the various kinds of work but also by those who control mine policies. Here is another case where "in union there is strength", and if the right kind of cooperation is kept in effect, it is certain that the desired results will also be forthcoming in lowered accident rate, with correspondingly decreased compensation and kindred costs and also in decreased suffering to the miners and their

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families. In accomplishing these very desirable results much educational work undoubtedly is necessary, with intensive supervision and well-directed discipline the dominant factors; and the type of discipline most likely to produce results of the right kind is that by which the supervisor explains in one manner or other to the workers the correct, safe, and efficient manner of doing mine work. This educational work becomes increasingly inportant with the rapid alteration of mining practice brought about by mine mechanization.

SUGGESTIONS ESPECIALLY APPLICABLE TO MECHANIZED COAL MINING

The suggestions given are more or less general in nature and applicable not only to mechanized mining but to other types as well. In the following are some suggestions applying more specifically to mechanized coal mining:

1. Where concentrated systems of mining are used, there should be ample, competent supervision; as a minimum, there should be at least one supervising official or "boss" in constant attendance for about each 25 underground workers. These immediate, "always on the job" bosses should be experienced in mining as well as have a good working knowledge of electricity, machinery, and handling men, and ultimately it is going to be found that these bosses must have technical training if mechanized mining is to be as successful as it could and should be.

2. It should be known to a certainty that those in actual charge of underground operation of the concentrated systems are in full sympathy with the system, at least in so far as giving it a fair, square trial is concerned.

3. Ventilation should be planned and conducted even more carefully to and past working faces than where older systems of work are used. In a coal mine, no single entries should be driven longer than 200 feet, and reliance should not be placed on any form of intermittent ventilation, such as is almost invariably found where blowers and tubing are used.

4. None but the safest available types of electrical equipment, wiring, and installations should be allowed when mechanical work is being done at or close to face regions; this is true even where no explosive gas has been found.

a. Wiring should be thoroughly insulated, well-supported, and strung along the rib or other place as far as feasible from probable contact with workers or with combustible material.

b. Bare or poorly insulated wires or open electrical switches should not be placed along or even fairly close to the roof in parts of a mine where methane may accumulate if ventilation is interrupted.

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c. Only permissible electrical equipment should be used at or near faces that are or are likely to be gassy or dusty. Open types of electrical equipment, such as conveyor or hoist motors, trolley or cable-reel locomotives, drills, etc., are decidedly dangerous when used near working faces from which coal dust is given off and are much more dangerous when explosive gas also may be present. Generally, at least two men should be present where heavy types of electrical equipment are used in mines.

d. Incandescent electric lights and light wires are dangerous when used at or near faces that are or are likely to be dusty or gassy. Only up-to-date permissible storage-battery or similar lighting of known safety and effectiveness should be used.

e. Although open-type electric motors or switches or bare electric wires should not be allowed at or near faces that are or may become dusty or gassy, it is realized that such equipment is being and probably will continue to be so used, and it is suggested that such equipment is much more likely to be partly safe if kept fairly close to the floor rather than close to the roof, the latter being the practice in many probably most cases.

f. Utmost care should be taken in the safeguarding of electric trailing cables; they are a constant hazard, and a "blow-up" may precipitate an explosion or a fire.

5. There should be ample, safe clearance for workers around mechanical equipment used at or near faces, the clearance being such that workers are not required to pass over or under moving or electrically charged equipment, with the possibility or probability of being injured when so doing. Moving belts, gears, trailing or other power cables, etc., on or adjacent to equipment used at or near face regions should be safely protected by adequate guards.

6. The noise made by machinery makes it difficult, if not impossible, to hear the usual warning sounds given by overhanging roof or rib material before it falls. Every feasible means should be taken to reduce noise where mechanical equipment is used at or around face regions; in connection with certain types of mechanical equipment, such as conveyors, the use of water not only tends to reduce noise but also aids materially in reducing dust in and around the equipment and in the general surrounding atmosphere. The equipment used at or near faces should be stopped at intervals not to exceed an hour to try to detect any sounds or signs of movement of roof or rib. In cutting entries, crosscuts, or rooms by machine it is desirable to stop the machine at least two or three times during the period of cutting.

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7. In general, it is much safer and even less expensive to protect concentrations of workers in the newer systems by use of cribs (which may or may not be removable) rather than to depend on props. Props should be used as an auxiliary to the cribs or as a supplement to the cribs. The unsupported space should be held to a minimum where men must work and failure to keep this regulation in effect has cost many lives in connection with mechanized mining.

8. When timber at or around mechanized faces is removed or torn out by machinery or by blasting, there should be no delay in its replacement, even when such action may cause temporary interruption of the usual coal-producing work. Failure to keep this precaution in effect is one of the most prolific causes of both fatal and nonfatal roof-fall accidents at and around mechanized working places.

9. After blasting there should be no hesitancy in taking ample time to place timber and to clear the air of harmful constituents before allowing the loaders to start operations. Many accidents occur through overeagerness to start loading as soon as possible after blasting, virtually irrespective of roof conditions or of conditions as to dust or gases.

10. Where at all feasible no blasting should be done when the working shift is in the mine, and all blasting in coal mines should be done by competent shot firers using only permissible explosives shot electrically, with not over 1-1/2 pounds of explosive per hole and with holes well tamped with incombustible matter (in other words coal-dust should not be used for stemming). By far the safest method of coal-mine blasting is that where all explosive is held out of the mine during the working shift and all holes are loaded by shot firers after the shift and are fired electrically from the surface with all persons, including the shot firers, out of the mine.

11. Although the above methods of blasting are absolutely practicable as well as safe, it is recognized that many concentrated mechanized systems are held to depend on being able to blast at any time; hence the following recommendations are given as to blasting practice when the working shift is in the mine, with the intent to safeguard as much as possible a practice known to be inherently unsafe:

a. All holes should be loaded and fired by shot firers.

b. Only permissible explosives should be used in a coal mine, whether to bring down coal or to shoot rock. Certainly no black blasting powder or dynamite should be used in any coal mine while any men are in the mine. No hole should be charged with more than 1-1/2 pounds of permissible explosive, when the men are in the mine, and a large enough number of holes should be provided to allow using less than 1-1/2 pounds of explosive per hole.

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c. Blasting should be done by permissible electric blasting units. Blasting from the power circuit is hazardous in the extreme, and it certainly should not be done with the concentration of men usually found at mechanized faces.

d. All holes should be tamped with inert stemming; this includes blasting with Cardox, as well as with permissible or other explosives.

e. There should be no solid shooting of coal, or "adobe" blasting of coal or rock, even when using permissible explosives.

f. Holes should not be loaded and tamped while workers other than the shot firers are closer than 25 feet.

g. Under no circumstances should holes be loaded while electrical equipment, such as electric drills or electric coal-cutting machines, is working within 25 feet.

h. Preferably the face region should be wet down well before blasting.

i. Workers should be withdrawn at least 500 feet before blasting, and ample warning given haulage and other adjacent workers; loaders and other face workers should not be allowed to return after the blast until the face that has been blasted has been given a careful examination by a competent fireboss for explosive gas or harmful fumes from explosives, as well as for hazardous roof conditions or possible missed shots.

It is important that ample time be given the above inspection to make it a thorough one; otherwise, there are certain to be numerous disasters in the concentrated working of coal mines. Likewise ample time should be taken to remove any dangerous condition before workers are permitted to resume loading and like operations.

j. Where shots fail to detonate, loaders and similar workers should not be allowed within 50 feet of them until these shots have been fired or otherwise safely handled. Misfired shots should not be handled while the working shift is in the mine.

12. With the concentration of workers and of tonnage effected by the newer systems there should be ample opportunity for better ventilation rather than the poorer type usually found at the places of concentrated work, compared with the greater scattering of workers and working places under the older systems.

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a. As stated heretofore, single entries longer than 200 feet should not be allowed; they are difficult to ventilate, and in case of a fall men are likely to be trapped.

b. Blower fans and tubing should not be allowed in any coal mine; however, it is recognized that they are being used and probably will continue to be used, and the following requirements should be kept rigidly in effect if this equipment is to be kept in even reasonable safety.

(1) The fan should be operated continuously 24 hours a day.

(2) The fan and pipe or tubing should be inspected frequently and always kept in repair. The tubing should be fire-resistant and should not lie along the floor unless it is of rigid material, and it should be kept free of kinks.

(3) Frequent tests of the air in the face of the heading should be made to determine both oxygen and explosive gas content.

(4) If possible, the fan should be driven by compressed air; if electrically driven, the motor and switches should be of explosion-proof type and an armoured power conductor employed. The switch should be situated down as far as feasible from the roof.

(5) The vicinity of the fan location should be made and kept fireproof.

(6) To avoid recirculation of air, the fan should always be installed on the fresh-air side of the place to be ventilated, and the fan inlet should be not less than 8 feet from the nearer rib of the place ventilated or of the last crosscut, as the case may be.

(7) When so placed, the fan should not take more than 40 percent of the air current in which it is placed.

(8) The discharge end of the pipe or tubing should be maintained not less than 20 feet from the face.

(9) If the fan should be stopped for any reason and gas accumulated at the face, the gas should be moved under the direct supervision of the foreman, and electrical equipment should not be

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operated at the face or on the return from the face region until thorough tests for gas have been made and the region found free of gas hazard.

c. Workers should be withdrawn from any place or face where electrically driven machines are in use when the methane content is over 1-1/2 percent.

d. When a fall cuts air circulation from any working face using concentrated mining, no workers should be allowed in the region (other than a limited number to restore air circulation) until ordinary ventilation has been restored. This seems an unnecessary recommendation, yet instances occur where the desire to complete the cycle of operations leads to the forcing of work even when conditions are known to be dangerous.

e. The main fan should always be located on the surface.

13. No nonpermissible electric locomotives should be allowed close to any face that gives off or is likely to give off methane; this includes cable-reel and nonpermissible storage-battery locomotives.

14. Under no circumstances should trolley locomotives be used in return air or within 300 feet of any face that gives off or is likely to give off methane or within 100 feet of any place where explosives are being used to charge drill holes.

15. Where multiple shifting is done, the greatest vigilance should be used to reduce to a minimum the let-down in discipline and vigilance known to accompany night-shift work in mining.

16. As with all kinds of underground mining, lighting is of utmost importance in mechanized mines, and up to the present time the safest and most dependable light available is the up-to-date electric cap lamp when kept in good condition as to charging and maintenance. Face lighting by incandescent globes attached to power lines is both awkward and hazardous; and the available types of flood lights, while better than incandescent globe lighting, are hazardous due to glare, shadows, etc., unless placed very carefully.

17. Mechanized processes of various kinds in the face region usually produce much dust not only in the air but also on adjacent surfaces, constituting not only an explosion hazard but also promoting greatly diminishing visibility, and constituting not only a nuisance to the eyes, ears, skin and respiratory passages but also adversely affecting health. Use of water on the cutter bar of mining machines, on the coal piles, and on the mine surfaces,

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especially those at and adjacent to the face region, greatly aids in curtailing the dust. Increasing the volume and velocity of the air sweeping the face region is another excellent method of diminishing the dust content of the air in which mechanized work is done.

18. Haulage, as affecting accident occurrence, constitutes one of the most difficult problems to solve, not only in mechanized mining but in all types of mining operations. Virtually all of the precautionary measures pertaining to nonmechanized (loading) types of mining apply with equal force to concentrated mechanized systems, and the latter have numerous added hazards to be avoided. Certainly the tracks should be laid and ballasted much better than the usual mine track with the greatly increased demand for quick handling required in the concentrated mechanized loading work. Clearance of all kinds should be even greater than in the older types of mining; cars, brakes, trailing cables, and other equipment should be kept in the best possible repair; and very well defined signaling methods should be devised to overcome the usually large amount of pushing of cars (always dangerous procedure in mines) that generally accompanies haulage in mechanized mining. Certainly the trolley locomotive system should not be extended closer than some hundreds of feet from mechanized faces with their rapid advance of face and accompanied increase of gas and dust released.

CONCLUSIONS

Mechanization, with especial reference to face loading, has not been done long or extensively enough to give a definite answer regarding the ultimate effect on accident occurrence. To date the record appears to indicate an increased rate of accidents at first, with ultimately a much lowered rate provided due care is taken to overcome the hazards almost always induced by the increased use of machinery, especially when the machinery is placed in confined, relatively poorly lighted places such as are likely to be found in mine workings. However, within the past 10 years, more especially within the past 5 years, some extremely good accident records have been established and maintained by highly mechanized coal-mining operations. In fact, there is good reason to believe that when our coal-mining people face the fact that mechanized methods have new and serious hazards (even though they may eliminate others), and then seriously investigate the nature of those hazards and institute and maintain available remedies, the mechanization of our mines (coal as well as noncoal) will ultimately result in materially reduced occurrence of accidents and also in reduction in all accident rates, whether based on an exposure or on a production basis.

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